

Mark Scheme (Results)

January 2011

GCE

GCE Chemistry (6CH05/01)

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Section A (multiple choice)

Question Number	Correct Answer	Mark
1	D	1

Question Number	Correct Answer	Mark
2	C	1

Question Number	Correct Answer	Mark
3	B	1

Question Number	Correct Answer	Mark
4	C	1

Question Number	Correct Answer	Mark
5	B	1

Question Number	Correct Answer	Mark
6	A	1

Question Number	Correct Answer	Mark
7	D	1

Question Number	Correct Answer	Mark
8 (a)	A	1

Question Number	Correct Answer	Mark
8 (b)	D	1

Question Number	Correct Answer	Mark
8 (c)	C	1

Question Number	Correct Answer	Mark
8 (d)	A	1

Question Number	Correct Answer	Mark
9 (a)	C	1

Question Number	Correct Answer	Mark
9 (b)	A	1

Question Number	Correct Answer	Mark
9 (c)	D	1

Question Number	Correct Answer	Mark
10	C	1

Question Number	Correct Answer	Mark
11	A	1

Question Number	Correct Answer	Mark
12 (a)	D	1

Question Number	Correct Answer	Mark
12 (b)	A	1

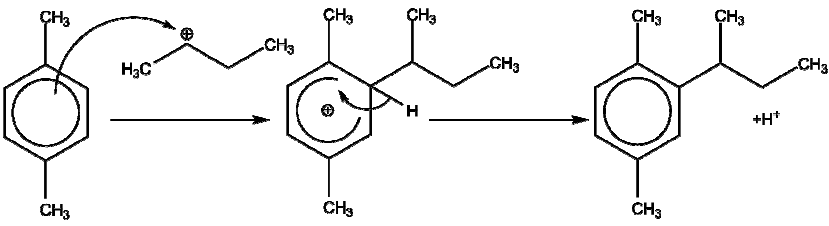
Question Number	Correct Answer	Mark
13	B	1

Question Number	Correct Answer	Mark
14	D	1

TOTAL FOR SECTION A = 20 MARKS

Section B

Question Number	Acceptable Answers	Reject	Mark
15 (a) (i)	Electrophilic substitution (any order)		1

Question Number	Acceptable Answers	Reject	Mark
15 (a) (ii)	$\text{AlCl}_3 + \text{CH}_3\text{CH}(\text{Br})\text{CH}_2\text{CH}_3 \rightarrow \text{AlCl}_3\text{Br}^- + \text{CH}_3\text{C}^+\text{HCH}_2\text{CH}_3$ ALLOW $\text{CH}_3\text{CH}(\text{Br})\text{CH}_2\text{CH}_3 \rightarrow \text{Br}^- + \text{CH}_3\text{C}^+\text{HCH}_2\text{CH}_3$ Ignore position of the + for this mark Ignore curly arrows in this equation (1)  Electron pair (curly arrow) from ring to positively charged second carbon of carbocation (1) Structure of intermediate must include positive sign (1) Electron pair from C-H bond reforms delocalized ring (1)	AlCl_4^-	4

Question Number	Acceptable Answers	Reject	Mark
15 (b)	Advantage Graphite catalyst easier to remove / separate / can be filtered off (from reaction mixture) / graphite can be re-used (1) Justification AlCl_3 is soluble or graphite is insoluble / different state / different phase OR Graphite can be re-used (1) Mark independently	Just graphite is a heterogeneous catalyst	2

Question Number	Acceptable Answers	Reject	Mark
15 (c) (i)	(Conc) nitric acid (1) (Conc) sulfuric acid (1) penalise dilute once only		2

Question Number	Acceptable Answers	Reject	Mark
15 (c) (ii)	Greater electron density in ring / ring is activated / more susceptible to electrophilic attack (1) Due to electron releasing / donating methyl groups (1)	Just more susceptible to attack	2

Question Number	Acceptable Answers	Reject	Mark
15 (c) (iii)	Reduction ALLOW redox	Hydrogenation	1

Question Number	Acceptable Answers	Reject	Mark
15 (c) (iv)	NaNO₂ / sodium nitrite / sodium nitrate(III) & HCl (any strong acid) (1) Temp 0-10° C / less than 10° C / any quoted temperature between 0 -10° C / in ice bath (1) $\text{C}_6\text{H}_3(\text{CH}_3)_2\text{NH}_2 + \text{HNO}_2 + \text{HCl} \rightarrow \text{C}_6\text{H}_3(\text{CH}_3)_2\text{N}_2^+\text{Cl}^- + 2\text{H}_2\text{O}$ (1) Add phenol dissolved in alkali (1) $(\text{C}_6\text{H}_3(\text{CH}_3)_2\text{N}_2^+\text{Cl}^- + \text{C}_6\text{H}_5\text{OH}) \rightarrow \text{C}_6\text{H}_3(\text{CH}_3)_2\text{N}_2\text{C}_6\text{H}_4\text{OH} + (\text{HCl})$ (1) Mark given for correct organic product Allow correct organic product shown as -O⁻ instead of -OH Mark independently	HNO ₃	5

Question Number	Acceptable Answers	Reject	Mark
16 (a) (i)	$(\text{COOH})_2 \rightarrow 2\text{CO}_2 + 2\text{H}^+ + 2\text{e}^-$ (1) $\text{MnO}_4^- + 8\text{H}^+ + 5\text{e}^- \rightarrow \text{Mn}^{2+} + 4\text{H}_2\text{O}$ (1)		2

Question Number	Acceptable Answers	Reject	Mark
16 (a) (ii)	$5(\text{COOH})_2 + 2\text{MnO}_4^- + 6\text{H}^+ \rightarrow 10\text{CO}_2 + 2\text{Mn}^{2+} + 8\text{H}_2\text{O}$ ALLOW multiples ALLOW $5(\text{COOH})_2 + 2\text{MnO}_4^- + 16\text{H}^+ \rightarrow 10\text{CO}_2 + 2\text{Mn}^{2+} + 8\text{H}_2\text{O} + 10\text{H}^+$ Ignore state symbols even if incorrect	Equation with electrons left in	1

Question Number	Acceptable Answers	Reject	Mark
16 (a) (iii)	Moles of $\text{MnO}_4^- = 11.30/1000 \times 0.010 = 1.13 \times 10^{-4}$ (mol) (1) Moles of $(\text{COOH})_2$ in $10 \text{ cm}^3 = 1.13 \times 10^{-4} \times 5/2 = 2.825 \times 10^{-4}$ (mol) (1) Moles of $(\text{COOH})_2$ in whole sample $= 2.825 \times 10^{-4} \times 50 = 0.01412(5)$ (mol) (1) Mass of acid $= 0.01412(5) \times 90 = 1.27 \text{ g}$ (1) % in leaves $= 1.27/250 \times 100 = 0.51$ (%) (1) If ratio 5 : 2 is not used, maximum (4) e.g. if ratio 2:5 is used then percentage in leaves = 0.08%	TE for 5th mark if % is greater than 100% Rounding errors once in first 4 marks Final answers not quoted to 2 dp	5

Question Number	Acceptable Answers	Reject	Mark
16 (a) (iv)	$\pm 0.05 \text{ cm}^3$ (1) $[(0.05 \times 2) / 11.3] \times 100 = 0.88\%$ (1) ALLOW $\pm 0.025 \text{ cm}^3$ (1) $[(0.025 \times 2) / 11.3] \times 100 = 0.44\%$ (1) ALLOW TE for second mark		2

Question Number	Acceptable Answers	Reject	Mark
16 (a) (v)	Any two from: Only one titration carried out (1) Leaves may contain other substances that MnO_4^- could oxidize/ react with (1) Not all ethanedioic acid extracted from leaves (1) ALLOW temperature too low / below 60°C (1) Different amounts of acid from different leaves (1)	Errors in technique e.g. transfer errors	2

Question Number	Acceptable Answers	Reject	Mark
16 (a) (vi)	(Wearing gloves suggested as) ethanedioic acid is toxic / harmful OR rhubarb leaves are toxic /harmful (1) (Unnecessary because) it is (very) dilute / present in small amounts (1) ALLOW because is not absorbed through the skin Second mark is independent of the first	References to weak acid Rhubarb is toxic	2

Question Number	Acceptable Answers	Reject	Mark
16 (a) (vii)	(Cloudiness due to) MnO_2 (solid /precipitate) (1) Ignore colour of precipitate EITHER Suitable use of $E^\ominus$ (+0.34V) OR MnO_4^- ions are a strong enough oxidizing agent to oxidize Cl^- ions (1)		2

Question Number	Acceptable Answers	Reject	Mark
16 (b) (i)	$(1s^2)2s^22p^63s^23p^63d^5(4s^0)$	$4s^2 3d^3$	1

Question Number	Acceptable Answers	Reject	Mark
16 (b) (ii)	Octahedral		1

Question Number	Acceptable Answers	Reject	Mark
17 (a) (i)	(Ligands cause) d orbitals / sub-shell / sub level to split (1) Some frequencies of light (energy) are absorbed (1) To promote electrons (within d level / $d \rightarrow d$ transitions) (1) ALLOW as alternative for second mark Remaining light is transmitted / reflected (resulting in the colour seen) Mark independently	Description of flame test	3

Question Number	Acceptable Answers	Reject	Mark
17 (a) (ii)	Concentrated HCl / HCl / HCl (aq) (1) Ligand exchange / replacement / substitution (1) Mark independently	Dilute HCl	2

Question Number	Acceptable Answers	Reject	Mark
17 (b) (i)	$[\text{Cr}(\text{H}_2\text{O})_6]^{3+} + \text{H}_2\text{O} \rightleftharpoons [\text{Cr}(\text{H}_2\text{O})_5(\text{OH})]^{2+} + \text{H}_3\text{O}^+$ (1) (1) ALLOW $[\text{Cr}(\text{H}_2\text{O})_6]^{3+} + \text{H}_2\text{O} \rightleftharpoons [\text{Cr}(\text{H}_2\text{O})_5(\text{OH})]^{2+} + \text{H}_2\text{O} + \text{H}^+$ (1) (1) ALLOW second mark for number of H_3O^+ ions related to incorrect complex e.g. $[\text{Cr}(\text{H}_2\text{O})_4(\text{OH})_2]^{2+} + 2\text{H}_3\text{O}^+$ scores second mark Ignore state symbols even if wrong		2

Question Number	Acceptable Answers	Reject	Mark
17 (b) (ii)	The concentration of oxonium / hydrogen ions is less in the $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$ / fewer hydrogen ions produced or reverse argument based on Cr ion (1) ALLOW $[\text{Cr}(\text{H}_2\text{O})_6]^{3+}$ / chromium ion deprotonates more easily if H_3O^+ shown in equation in (b) (i) Because copper ion is 2+ whilst the chromium ion is 3+ / charge on copper ion is less than charge on Cr ion / less charge density on 2+ ions / Cr (3+) draws more electron density from the O-H bond (1)	Just chromium complex more acidic The concentration of oxonium / hydrogen ions is greater in the $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$ / more hydrogen ions produced Ligand exchange	2

Question Number	Acceptable Answers	Reject	Mark
17 (c)	$\text{Cr}(\text{OH})_3$ / $\text{Cr}(\text{H}_2\text{O})_3(\text{OH})_3$		1

Question Number	Acceptable Answers	Reject	Mark
17 (d)	NaOH is a (strong) base / alkali (1) $\text{Cr}(\text{H}_2\text{O})_3(\text{OH})_3$ loses (three) protons / undergoes further deprotonation OR $\text{Cr}(\text{OH})_3$ is amphoteric (so reacts with strong bases) (1) To reverse reaction 4 add (sulfuric) acid / H^+ / HCl (1)	Chromium is amphoteric	3

Question Number	Acceptable Answers	Reject	Mark
17 (e)	$[\text{Cr}(\text{NH}_3)_6]^{3+} + (\text{edta})^{4-} \rightarrow [\text{Cr}(\text{edta})]^- + 6\text{NH}_3$ (1) Ignore missing brackets Ignore state symbols even if wrong During the reaction number of particles increases (2 to 7) / more moles of product than reactants AND entropy (of system) increases (1)	Entropy increases because a gas is produced only Just more products than reactants	2

TOTAL FOR SECTION B = 50 MARKS

Section C

Question Number	Acceptable Answers	Reject	Mark
18 (a) (i)	Mass of C in CO₂ = $12/44 \times 0.88 = 0.24$ g Mass of H in H₂O = $2/18 \times 0.216 = 0.024$g (1) So mass of oxygen = $0.328 - (0.24 + 0.024) = 0.064$ g (1) Moles of C = $0.24/12 = 0.02$ Moles of H = $0.024/1 = 0.024$ Moles of O = $0.064/16 = 0.004$ (1) Ratio = simplest ratio = 5:6:1 so C₁₀H₁₂O₂ (1) OR Moles of CO₂ $0.88/44 = 0.02$ Moles of H₂O $0.216/18 = 0.012$ (1) Moles of H = 0.024 therefore ratio of C:H is 5:6 (1) Can gain remaining two marks if they continue calculation as above OR C₁₀H₁₂O₂ = 164 (1) Percentage carbon is $120/164 = 73.2\%$ Percentage hydrogen is 7.3% Percentage oxygen is 19.5% (1) Mass of carbon = $73.2 \times 0.328/100 = 0.24$ Mass of hydrogen = $7.3 \times 0.328/100 = 0.024$ Mass of oxygen = $19.5 \times 0.328/100 = 0.064$ (1) Mass of carbon in CO₂ is $12/44 \times 0.88 = 0.24$ Mass of hydrogen in H₂O is $1/9 \times 0.216 = 0.024$ (1) OR Mass of C in CO₂ = $12/44 \times 0.88 = 0.24$ g Mass of H in H₂O = $2/18 \times 0.216 = 0.024$g (1) So mass of oxygen = $0.328 - (0.24 + 0.024) = 0.064$ g (1) Percentage of C = $0.24/0.328 = 73.2\%$ Percentage of H = $0.024/0.328 = 7.3\%$ Percentage of O = $0.064/0.328 = 19.5\%$ (1) C₁₀H₁₂O₂ = 164 Percentage carbon is $120/164 = 73.2\%$ Percentage hydrogen is $12/164 = 7.3\%$ Percentage oxygen is $32/164 = 19.5\%$ (1)		4

Question Number	Acceptable Answers	Reject	Mark
18 (a) (ii)	Add (small amount of) Br ₂ / bromine (1) (Br ₂ turns from orange / yellow / red-brown to) colourless / decolourised (1) OR Add (small amount of) acidified KMnO ₄ (aq) (1) KMnO ₄ (aq) turns from purple/pink to colourless / brown (1) OR Add (small amount of) alkaline KMnO ₄ (aq) (1) KMnO ₄ (aq) turns from purple/pink to green (1)	clear	2

Question Number	Acceptable Answers	Reject	Mark
18 (a) (iii)	(Heat under) reflux OR microwave (in sealed container)		1

Question Number	Acceptable Answers	Reject	Mark
18 (a) (iv)	CH ₃ COCl / CH ₃ COO(COCH ₃) / ethanoyl chloride / ethanoic anhydride ALLOW CH ₃ COOH / ethanoic acid and H ₂ SO ₄ / sulfuric acid / HCl / hydrochloric acid	Correct answer plus AlCl ₃ Acyl chloride	1

Question Number	Acceptable Answers	Reject	Mark
18 (b) (i)	steam source and r.b / pear-shaped flask (and clove buds) OR r.b / pear-shaped flask being heated and containing water (and clove buds) (1) Condenser with water jacket, in correct position and direction of water flow (1) Collection vessel (1) -1 if apparatus does not work e.g. sealed -1 for no joints or leaky joint	Conical flask if being heated with the clove buds in	3

Question Number	Acceptable Answers	Reject	Mark
18 (b) (ii)	Mix organic solvent and oil-water mixture in a separating funnel then separate (1) Distil / rotary evaporate (to separate clove oil from organic solvent) (1) Add (anhydrous) CaCl_2 / (anhydrous) MgSO_4 / (anhydrous) Na_2SO_4 / silica gel / calcium oxide to clove oil, (then filter / decant) (1) ALLOW name or formula of drying agent (Second and third marks in either order) OR Add (saturated solution) of NaCl / sodium salt (1) Separate in a separating funnel (1) Add named drying agent to clove oil, (then filter / decant) (1)	(Anhydrous) CuSO_4 NaOH , sodium carbonate, sodium hydrogencarbonate, calcium carbonate	3

Question Number	Acceptable Answers	Reject	Mark
18 (c)	Choice with justification (1) e.g. 'yes it's reasonable as clove oil may be in use at harmful /toxic levels so we need to identify what that level is' 'no as clove oil has been in use for many years in many ways so tests on animals not necessary to confirm it's safe to use at current levels' / no, as humans would have to consume large amounts	Yes because it's toxic No, because of objections to animal testing in general	1

Question Number	Acceptable Answers	Reject	Mark
18 (d)*	4 clear justified comparisons - 1 mark each ScCO₂ oil obtained seems purier (as colour closely matches that of eugenol) requires no further purification, (others use solvent extraction) greater yield per hour yield 15.3g per 100g of buds no organic solvent (because it is chlorinated) and so environmental problems / harmful / damage ozone layer requires high pressure so likely to be expensive / requires specialist equipment Steam distillation steam distillation can be done using standard lab equipment / does not require high pressures yield only 6.1g / 6.2g per 100g of buds Steam gives the least yield per hour Soxhlet produces greater yield of oil but has a smaller percentage of eugenol / eugenol ethanoate yield 16.8g per 100g of buds (takes longer) but does not require high pressures uses organic solvent (because it is chlorinated) and so environmental problems / harmful / damage ozone layer Oil obtained seems least pure (4) Synthetic route has several steps, each with a low yield clove buds are renewable but materials in synthesis are not / materials in synthesis likely to be obtained from oil (1)	produces pale yellow oil Just no organic solvent Only two hours / shorter time than other methods Just higher percentage yield Just no organic solvent Higher yield than soxhlet Cost of chemicals Yield is 35 %	5

TOTAL FOR SECTION C = 20 MARKS

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